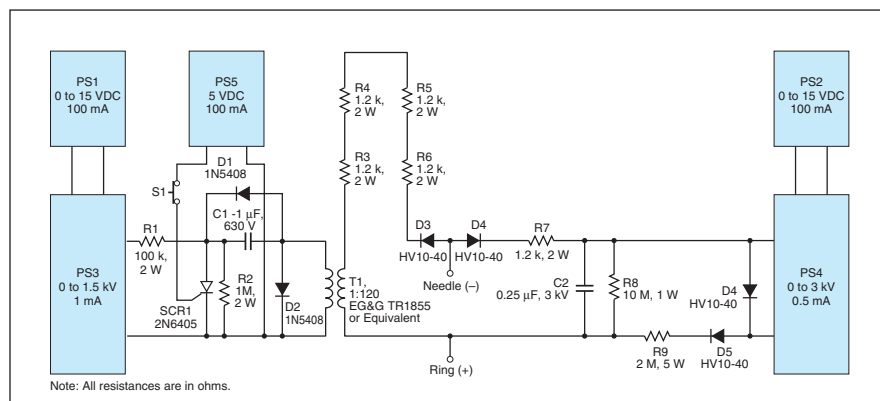


droplet is a ring electrode. A bias high voltage, followed by a high-voltage pulse, is applied so as to attract the droplet sufficiently to pull it off the needle. The voltages are such that the droplet and needle are negatively charged and the ring electrode is positively charged.

The droplet-dispenser circuit (see figure) includes power supply PS2, which energizes DC-to-DC converter PS4 to produce the bias voltage. A bias voltage of the order of 3 kV has been found to be effective. PS4 charges capacitor C2 through current-limiting resistor R9. Bleed resistor R8 discharges C2 for safety when the circuit is not in use. Diodes D5 and D6 protect PS4 from inductive voltage spikes. The droplet is charged via steering diode D4 and current-limiting resistor R7.

Power supply PS1 energizes DC-to-DC converter PS3 to charge capacitor C1 via current-limiting resistor R1. Charging C1 to 100 volts has been found to be effective. Bleeder resistor R2 discharges C1 for safety when the circuit is not in use. Silicon controlled rectifier SCR1 conducts when push-button switch S1 is closed momentarily, producing a microsecond pulse in the primary winding of transformer T1. Diodes D1 and D2 protect SCR1 from inductive spikes. When C1 has been charged to 100 V, a pulse of 12 kV is



This **Electronic Circuit** of the high-voltage droplet dispenser generates a steady high bias voltage, upon which it superimposes a high-voltage pulse to release a droplet.

produced at the secondary winding of T1; however, the circuit is capable of generating a pulse of as much as 40 kV. The pulse provides ionization energy to the droplet via steering diode D3 and current-limiting resistors R3, R4, R5, and R6. This energy causes the release of the droplet. The four current-limiting resistors (instead of only one resistor with four times the resistance of one of them) are used here to enable this part of the circuit to withstand the high-voltage pulse.

Before the circuit is turned on, PS1 and PS2 are set to the minimum voltage levels. Then they are turned on along with PS5. Next, PS1 and PS2 are set to

the desired voltage levels. Finally, S1 is closed momentarily to release the droplet. The circuit as described here was designed for manual control, but is readily adaptable to control by a microprocessor.

This work was done by Dennis J. Eichenberg of Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17190.

Network Extender for MIL-STD-1553 Bus

Long-distance communications and equipment tests can be effected through a single multicoupled source.

Lyndon B. Johnson Space Center, Houston, Texas

An extender system for MIL-STD-1553 buses transparently couples bus components at multiple developer sites. The bus network extender is a relatively inexpensive system that minimizes the time and cost of integration of avionic systems by providing a convenient mechanism for early testing without the need to transport the usual test equipment and personnel to an integration facility. This bus network extender can thus alleviate overloading of the test facility while enabling the detection of interface problems that can occur during the integration of avionic systems. With this bus extender in place, developers can correct and adjust their own hardware and software before products leave a development site. Currently resident at Johnson

Space Center, the bus network extender is used to test the functionality of equipment that, although remotely located, is connected through a MIL-STD-1553 bus. Inasmuch as the standard bus protocol for avionic equipment is that of MIL-STD-1553, companies that supply MIL-STD-1553-compliant equipment to government or industry and that need long-distance communication support might benefit from this network bus extender.

The state of the art does not provide a multicoupler source for this purpose. Instead, the standard used by the military serves merely as an interface between a main computer in some device or aircraft and the subsystems of that device or aircraft — for example, a subsystem that controls wing flaps or ailerons.

Unfortunately, the transmission distance of a state-of-the-art MIL-STD-1553 system is limited to 400 ft (122 m). The bus network extender eliminates this distance restriction by enabling the integrated testing of subsystems that are located remotely from each other, without having to physically unite those subsystems. Interlinking by use of the bus network extender is applicable to 90 percent of all required testing for the military; hence, it offers the potential for savings in cost and time. There is also potential for commercial applications in simulation and training and in the development of real-time systems.

The bus network extender enables long-distance communications by use of specified media and compliant equipment, while conforming to all rel-

evant MIL-STD-1553 specifications, including those that pertain to response times and data formats. The bus network extender can also insert simulated or table-driven data addressed to any bus controller (BC) or remote-terminal (RT)/support-area (SA) network combination.

In a system under test, subsystems connected at a local site are connected to the bus network extender. After the connection is made, the output of a remote bus controller mimics the activity of the bus controller at the local site and can be configured to operate with multiple remote sites. The entire bus network is then controlled by a workstation coupled at the local site. The configuration of the bus network extender is controlled by a single text file that is created by the user and that can be modified at the local site.

In order to extend a network, the bus network extender effects a logical sequence of events. The BC (either simulated or hardware in the loop) first sends a MIL-STD-1553 message to the RT. The RT passes the message to a central processing unit (CPU). A master CPU reads the message and transmits an Ethernet (or equivalent) MIL-STD-1553 message to a slave CPU, which receives the message and begins building a MIL-STD-1553 BC message chain. The slave CPU then sends the MIL-STD-1553 message to the RT via BC hardware, a response to the message is received by the BC hardware, and the CPU is notified. After notification, a slave CPU returns the MIL-STD-1553 message response to the master CPU over the Internet. If the message is a

"transmit" message, the master CPU fills the destination RT data buffer with response data. Finally, new data become available to the hardware-in-the-loop or simulated BC.

The bus network extender also provides the following:

- An RT/SA address can be mapped to a different RT/SA on the remote RT to avoid having to change jumpers or reprogram an address.
- The system can be set to respond to some SAs by simulating other SAs. This capability enables testing even when some sensors or devices on a remote unit under test are unavailable.
- Multiple MIL-STD-1553 buses can operate simultaneously.
- Common configuration files can be used to control and document the interfaces to the bus-network-extender interfaces.
- Responses to MIL-STD-1553 messages can be generated in real time.
- It is possible to perform byte swapping for computers or firmware controllers that are based on different processor architectures.

Performance depends on the type of communication channel used to connect local and remote sites. In a compromise, commands are buffered by the bus network extender and appear, at least to the BC, to satisfy response-time requirements. However, data supplied by the bus network extender to the BC are transmitted from one or more frame times in the past. The system thus operates correctly with respect to protocol and timing but is subject to a delay in data content ranging from tens of milliseconds to seconds.

Such delays result from finite signal-propagation speed and are unavoidable. Notwithstanding such delays, the bus network extender is well suited for protocol and interface integration testing, even on slower links. On faster links, some systems equipped with the extender can cycle MIL-STD-1553 frames at full speed, subject to only inevitable data delays. Some systems equipped with bus network extenders may seem to operate in real time on high-speed links.

The bus network extender is equipped with utility software that, upon command, displays the status of all BCs, remote transmission queues, and RT message queues. The software also provides a configuration file for all connected systems to provide error-free configuration at all locations, a configuration file that contains an entire system interface control document, and an input file that performs extensive error checking. Since slave BCs are configured automatically, remote configuration data are totally eliminated when remote simulations are not required. Should a slave network server be unreachable, the extender attempts to re-establish network connections automatically while maintaining adherence to real-time-response requirements for all MIL-STD-1553 messages.

This work was done by Julius Marcus and T. David Hanson of GeoControl Systems, Inc., for Johnson Space Center. For further information, contact the Johnson Commercial Technology Office at (281) 483-3809.

MSC-22741

MMIC HEMT Power Amplifier for 140 to 170 GHz

Circuits like this one could be useful in radiometers for probing the atmosphere.

NASA's Jet Propulsion Laboratory, Pasadena, California

Figure 1 shows a three-stage monolithic microwave integrated circuit (MMIC) power amplifier that features high-electron-mobility transistors (HEMTs) as gain elements. This amplifier is designed to operate in the frequency range of 140 to 170 GHz, which contains spectral lines of several atmospheric molecular species plus subharmonics of other such spectral lines. Hence, this amplifier could serve as a prototype of amplifiers to be incorporated into heterodyne radiometers used in atmospheric science. The original

intended purpose served by this amplifier is to boost the signal generated by a previously developed 164-GHz MMIC HEMT doubler [which was described in "164-GHz MMIC HEMT Frequency Doubler" (NPO-21197), *NASA Tech Briefs*, Vol. 27, No. 9 (September 2003), page 48.] and drive a 164-to-328-GHz doubler to provide a few milliwatts of power at 328 GHz.

The first two stages of the amplifier contain one HEMT each; the third (output) stage contains two HEMTs to maximize output power. Each HEMT is char-

acterized by gate-periphery dimensions of 4 by 37 μm . Grounded coplanar waveguides are used as impedance-matching input, output, and interstage-coupling transmission lines.

The small-signal S parameters and the output power (for an input power of about 5 dBm) of this amplifier were measured as functions of frequency. For the small-signal gain measurements, the amplifier circuit was biased at a drain potential of 2.5 V, drain current of 240 mA, and gate potential of 0 V. As shown in